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## Research Article

## Daytime Sleepiness and the Well-Being and Academic Attainment of University Students in the UK

Kate Howells, Andrew P. Smith \*

School of Psychology, Cardiff University, 63 Park Place, Cardiff, CF10 3AS, United Kingdom; E-Mails: HowellsKA2@cardiff.ac.uk; smithap@cardiff.ac.uk

\* **Correspondence:** Andrew P. Smith; E-Mail: smithap@cardiff.ac.uk

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### Abstract

**Background:** Previous research suggests that insufficient daily sleep has negative effects on both well-being and academic attainment. Much of the research in this field has focused on adolescents and children rather than university students in the UK.

**Methods:** The present study used the Student Well-Being Process Questionnaire and independent sleep questions to measure subjective well-being and levels of sleep in a student sample (N=345) who completed the survey online. Academic attainment was measured with exam and coursework scores, which were obtained from the university.

**Results:** Results indicated that a factor of the sleep scale, 'tiredness and concentration', was significantly associated with reduced well-being and poorer academic attainment when controlling for other predictive factors. Insufficient sleep was also linked with anxiety and depression outcomes in students.

**Conclusions:** Findings add to current knowledge regarding the negative effects of sleep, although the causality cannot be determined due to the correlational nature of the research.

### Keywords

Daytime sleepiness; well-being; academic attainment; well-being process questionnaire



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## **1. Introduction**

Sleep is now thought of as a major public health concern, with more than a third of the population not getting enough sleep [1]. With university students enjoying more freedom than previously experienced, they are likely to choose irregular and insufficient sleep cycles, and are thought to be major contributors to this statistic with their changing sleep-wake patterns. High academic workloads may also lead to shorter and lower quality sleep [2]. Reportedly, 20-30% of children and adolescents in the general population have sleep complaints or difficulties [3]. These rates are elevated in children and adolescents with psychiatric, behavioural or emotional problems. Those who have disrupted sleep often report more depression, anxiety, irritability, fear, frustration, tenseness, emotional instability, inattention and behaviour problems, and drug and alcohol use [4], suggesting that insufficient sleep can result in serious consequences.

With having insufficient sleep during week nights, college students are noted to sleep for longer hours during the weekends to compensate. Twice as many students as those in the general population report symptoms in line with delayed sleep phase syndrome [5]. This syndrome is characterised by later wake times on non-school/work days, and leads to reduced sleep quality and increased sleepiness during the week, resulting in inadequate academic performance [6]. In one study, only 11% of the surveyed students met the criteria for sufficient sleep quality, with the rest of the sample reporting moderate-to-severe sleep complaints [7], therefore indicating that the majority of students suffer from sleep problems or complaints on a regular basis. Even those students who shift their sleep-wake cycles by two hours at the weekend but still sleep for 8 hours per night experience an increase in feelings of depression, reduced affability and concentration difficulties [8]. Insufficient sleep in university students is therefore a widespread issue in modern society.

### **1.1 Well-Being**

In the classic work on the structure of psychological well-being, Bradburn [9] made the initial distinction between positive and negative affect. However, it has subsequently been argued that the early conceptualisations of well-being neglected important aspects of psychological health [10]. Although there is not yet a concrete definition of well-being, it has been loosely defined as the combination of multiple associated variables, with negative, positive and subjective features, which are each considered independent parts of a whole [11]. The most significant predictor of well-being is thought to be personality [12], with different aspects of personality being associated with various features of well-being. For example, extraversion and agreeableness tend to be associated with positive affect, neuroticism is a strong predictor of negative affect, and conscientiousness is positively correlated with life satisfaction [13].

With university issues and psychological problems being greatly overlooked, there has recently been increasing interest in the physical and psychological well-being of students in the UK and the US, with high levels of depression, anxiety and stress reported in undergraduate students [14]. The growing interest is due to the lives of students becoming increasingly difficult in recent years, with changes to student grants and increasing academic pressures. With more and more young people attending universities in the UK, the pressure to achieve a respectable degree is far greater with increasing competition for future jobs [15]. Moreover, comparisons between students and the

general population have reported that the psychological well-being of students is worse than those of a similar age who do not have these university pressures [16].

With the increasing academic and financial pressure upon students, it is not surprising that one elevated aspect of well-being is anxiety. At the beginning of the first year at university, anxiety is one of the most prominent well-being aspects, scoring higher than all other domains [15]. This suggests that entering university is an anxious, rather than a depressive, time for new students. Further research has suggested that between one- and two-thirds of students report anxiety about their studies, which subsequently limits their capacity to work [17]. These anxiety conditions can have an impact on the attainment of students in their first year of university, reducing the potential likelihood of achieving higher grades [18]. Therefore, elevated aspects of well-being in students have the potential to negatively affect academic attainment.

Sleep is believed to be closely linked to the regulation of physical and emotional well-being. Early research indicates that poor sleep quality in students is associated with increased irritability, depression and lower life satisfaction [7]. Researchers have long noted an association between sleep disruptions and anxiety symptoms [19]. A recent study found that of the 129 children and adolescents with anxiety disorders, over half had three or more sleep disturbances, and 88% had at least one sleep problem [20]. Further, sleep disturbance symptoms in early childhood are associated with the occurrence of anxiety disorders over 20 years later [21].

Furthermore, it has been shown that depression, and not anxiety, is likely to be a risk factor for university students [22]. Lack of sleep in students has been significantly associated with depression outcomes. Individuals who have poor sleep quality, sleep less than 7 hours at night and experience increased sleepiness during the day manifest irritability as well as depressive symptoms [23]. In addition, students with depressive symptoms have more severe alterations to their sleep, feel under-rested after a night's sleep, and experience a greater number of awakenings as compared to those without depressive symptoms [23]. This suggests that poor sleep can result in depressive as well as anxiety outcomes, with depression also causing sleep problems. According to Havighurst [24], when adolescents and students fail to achieve specific developmental tasks, such as peer relationships, gender roles, achieving emotional independence, preparing for a career, and achieving socially responsible behaviour, this leads to unhappiness, disapproval by society and difficulty with subsequent tasks. These difficulties can also lead to depressive outcomes for students.

The current research used the Student Well-Being Process Questionnaire (WPQ [25]) to assess levels of subjective well-being in a student population. The WPQ is a set of measures that can be combined together to provide a multi-dimensional measure of well-being and the factors that contribute to well-being outcomes. The WPQ uses single-item measures to assess levels of subjective well-being. The practical benefits of a single-item measure relate to where more variables can be measured in less space. Although this can sometimes be at the expense of detail, shorter measures have benefits for research in terms of reduced cost and ease of interpretation [26]. Short-item measures have achieved a high status in research with their high degree of accuracy, from being developed carefully from the most influential aspects of the multi-item measures [27]. Indeed, the WPQ has proved its reliability in previous survey research [28-31].

The WPQ measures both positive (e.g. positive affect, life satisfaction and happiness) and negative (e.g. perceived stress, negative affect, anxiety and depression well-being) aspects of the well-being process. These can be analysed separately or an overall well-being score can be used

(the difference between positive and negative outcomes [32]). Established predictors include student stressors, negative coping, social support and positive personality (high self-esteem, optimism and self-efficacy). The effects of these established predictors are statistically controlled for prior to examining the effects of novel predictors (in this case the sleep measures).

### **1.2 Academic Attainment**

It is widely acknowledged that health and well-being are important for effective learning [33]. College students are known for their irregular sleep schedules and late bedtimes, with 25-50% of students reporting significant levels of daytime sleepiness [34]. This daytime sleepiness may interfere with academic performance and concentration during classes. Indeed, it has been reported that 21% of poor sleepers failed at least one year in school, while only 11% of normal sleepers showed similar problems [35]. While it is well documented that poor sleep negatively affects academic performance, there have been some inconsistencies in the literature. It has been reported that while sleep quality and feeling rested were highly related to school functioning, amount of time in bed has no relationship with this [36]. Further research has also found no correlation between sleep time and academic performance in adolescents [37]. Therefore, time spent asleep may not contribute to decreased academic performance but other aspects of sleep such as sleep quality and number of disturbances are likely to add to these academic consequences.

However, in an influential piece of research, Wolfson & Carskadon [38] studied sleep patterns and daytime functioning in more than 3,000 high school students. It was reported that those students with earlier bedtimes on weeknights, higher sleep quantity, and reduced weekend delays of sleep were those students that achieved higher grades. Indeed, those students who reported that they obtained less total sleep and later bedtimes, were those that also reported that they were failing at school [39], suggesting that sleep time might affect student performance. An interesting finding was that those who were sleep deprived performed worse on a cognitive task, but reported higher levels of estimated performance and more effort on tasks than non-sleep-deprived subjects [40]. Therefore, sleep-deprived individuals may expend more effort to complete the task but this is not adequate to overcome the performance decrements caused by being sleep-deprived. The WPQ also contains established predictors of academic attainment which must be controlled for prior to assessing the impact of sleep. The most reliable predictor is the personality trait of conscientiousness.

### **1.3 Current Research**

Associations between health and academic attainment have mostly been examined in elementary, middle or high school children in America, rather than university or college students in the UK [41]. Sample sizes of these studies have been generally small and normally below 300 participants. The current research focused on the effects of insufficient sleep on an individual's self-reported well-being and academic attainment at university in over 300 students. Students were required to complete a survey to assess their levels of well-being, and answer specific questions related to sleep, while their exam and coursework grades were collected through the university. Based on the findings from the previous literature it was hypothesised that those with poorer sleep would rate themselves as having inferior well-being, and this effect would be

significant when controlling for the established predictors of well-being. It was also hypothesised that poor sleep would negatively impact academic attainment at university. Again, it was predicted that this result would remain when controlling for the established predictors of academic attainment.

The survey was carried out with ethical approval from the Cardiff University School of Psychology Ethics Committee (Reference Number: EC.15.11.10.4280), and with the informed consent of each participant. All participants were debriefed online after completion of the survey.

## **2. Materials and Methods**

This study consisted of a survey to assess the well-being and sleep habits of students. Academic attainment scores were derived from the School of Psychology and anonymised before analysis. The survey data was collected prior to the Christmas break and the attainment results referred to the courses done in the fall semester and examined in January.

### **2.1 Participants**

345 first (N = 167) and second year (N = 178) Cardiff University Psychology undergraduates (38 men, 307 women) completed the survey. The sample size was large enough to detect small to medium effects of well-being and academic attainment. Their ages ranged from 18-48 years old (M = 19.6, SD = 2.4). Participants signed up to complete the survey and were given course credits for their time. The survey was completed anonymously by all participants.

### **2.2 Materials**

Self-report questionnaires were used to assess well-being and sleep habits. The survey consisted of the WPQ (student version) and independent sleep questions.

*Well-Being:* The WPQ consists of 43 questions including socio-demographic information (e.g. gender, age, year of degree), general health, life experiences, social support, positive personality, negative coping and well-being outcomes, which are measured using scales 1 (not at all/strongly disagree) to 10 (very much/strongly agree). These items were compiled by Williams [26] to assess well-being with single item measures, which can predict variance in well-being outcomes in students. Overall well-being is the combination of factors that are correlated but distinct, and total well-being was calculated from the sum of the positive scores added with the sum of reverse scored negative items. There are well-known established predictors of well-being which were derived from specific questions of the WPQ, namely social support, positive personality, negative coping and total number of stressors.

*Sleep:* A survey was devised, based on the literature, to assess levels of sleep. Quality of sleep on weekdays, how often students sacrifice sleep for studying, tiredness and lack of concentration due to lack of sleep were assessed as well as sleep disturbances and total hours slept during weekdays (see Figure 1).

1. What time do you go to bed on week days (use 24hr clock)?
2. What time do you get up during week days (use 24hr clock)?
3. Do you often sleep in the day? Not at all    1 2 3 4 5 6 7 8 9 10    Very often
4. Do you often feel tired during the day? Not at all    1 2 3 4 5 6 7 8 9 10    Very often
5. Do you often sacrifice sleep for studying? Not at all    1 2 3 4 5 6 7 8 9 10    Very often
6. Do you often feel tired during lectures? Not at all    1 2 3 4 5 6 7 8 9 10    Very often
7. Do you find it hard to concentrate during lectures? Not at all    1 2 3 4 5 6 7 8 9 10    Very hard
8. How often do you skip lectures due to tiredness? Not at all    1 2 3 4 5 6 7 8 9 10    Very often
9. Are you a morning person or an evening person? Morning    Evening
10. How would you rate the quality of your sleep? Very bad    1 2 3 4 5 6 7 8 9 10    Very good
11. How many disturbances do you have to your sleep per night? None        1        2        3        4        5+

**Figure 1** Sleep questions.

*Academic Attainment:* Academic attainment was assessed by an examination of grades, which consisted of 3 three-hour written examinations in January (on a 0-100% scale, where 40% is a pass and 70% is a first class grade), and coursework performance. Unlike overall examination scores, coursework addresses performance under non-examination conditions, and can be considered a less stressful evaluation of academic performance. An overall mark was calculated to provide an indicator of average attainment over both exams and coursework. Performance grades were obtained from the School of Psychology and all were anonymised before analysis.

The established predictors of academic attainment include conscientiousness, total stressors, how efficiently one does their work and how stressful students find their course.

## 2.3 Procedure

All students who agreed to participate received a survey packet consisting of the WPQ and independent sleep questions. The survey was advertised and conducted online. Students received course credits for the completion of the 45-minute survey. All students gave informed consent before completing the survey online, and all gave permission to use their exam and coursework scores as a measure of academic attainment. All scores were made anonymous before analysis.

## 2.4 Statistical Analysis

Factor analysis was used to determine underlying dimensions by merging all 11 sleep questions into meaningful constructs. Once completed, univariate correlations were used to determine whether these independent aspects of sleep had an effect on overall well-being outcomes. Of those factors that were associated with well-being, a multivariate regression analysis was completed to observe whether these results still applied when adjusting for established predictors of well-being (i.e. social support, negative coping, positive personality, and total stressors). Variables with non-significant correlations were not entered into the regression for the outcome. The same analysis procedure was carried out for academic attainment, i.e. correlations with factors of sleep and a multiple regression to establish whether the effects hold when adjusting for predictors of attainment. Independent correlations were carried out to examine the relationship between the factors of sleep and specific aspects of well-being, such as anxiety and depression.

## 3. Results

Descriptive statistics were calculated for specific answers related to sleep (see Table 1). It appeared that feeling tired during the day and during lectures, finding it hard to concentrate during lectures and quality of sleep were all highly rated. The descriptive statistics for the well-being and attainment measures are also shown in Table 1.

**Table 1** Descriptive statistics for sleep questions, attainment and well-being measures.

Sleep Question	M	SD
Do you often sleep in the day? (1 not at all – 10 very often)	3.45	2.5
Do you often feel tired during the day? (1 not at all – 10 very often)	6.61	2.21
Do you often sacrifice sleep for studying? (1 not at all – 10 very often)	4.86	2.62
Do you often feel tired during lectures? (1 not at all – 10 very often)	6.67	2.19
Do you find it hard to concentrate during lectures? (1 not at all – 10 very hard)	6.03	2.2
How often do you skip lectures due to tiredness? (1 not at all – 10 very often)	3.5	2.58
Are you a morning or an evening person? (1 morning - 2 evening)	1.76	0.43
How would you rate the quality of your sleep? (1 very bad – 10 very good)	6.34	2
How many disturbances do you have to your sleep per night? (0 – 5+)	2.41	1.28



<b>Attainment (%)</b>	<b>M</b>	<b>SD</b>
Overall	63.2	6.6
Exam	62.0	7.6
Coursework	68.5	7.1
<b>WPQ Measures</b>	<b>M</b>	<b>SD</b>
Stressors	35.30	9.24
Social Support	33.06	6.28
Negative Coping	17.63	4.53
Positive Personality	33.94	6.62
Conscientiousness	6.84	1.88
Overall well-being	37.25	9.31

### 3.1 Factor Analysis

A Principal Components Analysis with a Direct Oblimin (oblique) rotation of the 11 sleep related questions from the survey was conducted on the data from 345 participants, shown in Table 2. An examination of the Kaiser-Meyer Olkin measure of sampling adequacy suggested that the sample was factorable (KMO = 0.69).

**Table 2** Obliquely rotated component loadings for 11 survey items.

<b>Component</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
Do you often sacrifice sleep for studying?	0.88			
Do you often feel tired during lectures?	0.72			
Do you often feel tired during the day?	0.64			
Do you find it hard to concentrate during lectures?	0.56			
What time do you get up during week days (use 24hr clock)?		0.92		
What time do you go to bed on week days (use 24 hour clock)?		0.91		
How many disturbances do you have to your sleep per night?			-0.91	
How would you rate the quality of your sleep?			0.85	
Do you often sleep in the day?				-0.88
How often do you skip lectures due to tiredness?				-0.73
Are you a morning or an evening person?				-0.34

Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalisation.

The results of an oblique rotation of the solution are shown in Table 2. The analysis yielded a four-factor solution with a simple structure (factor loadings  $\Rightarrow$  .30). Four items loaded into Factor 1. It was clear from Table 2 that these items all relate to daytime tiredness and lack of concentration during lectures. This factor reflected reported levels of sacrificing sleep for studying,

feeling tired during lectures, feeling tired during the day, and concentration during lectures. This factor was labelled 'tiredness and concentration'. Two items loaded onto Factor 2, related to the amount of time slept by students. This factor reflected the reported levels of wake and sleep times of students during weekdays. This was labelled 'sleep duration'. Two items loaded onto Factor 3, and these were related to the amount of disturbance to sleep per night and the quality of students' sleep. This factor was labelled 'sleep quality'. The three items that loaded into Factor 4 were related to how often students slept during the day, how often they skipped lectures due to tiredness and whether they were a morning or an evening person. This factor was labelled 'daytime sleepiness'. It appeared that one question (Do you often feel tired during the day?) of the 'tiredness and concentration' factor seemed as though it was potentially also related to 'daytime sleepiness'. However, the distinction between these factors was that the tiredness and concentration' factor related to feeling tired in general, and the 'daytime sleepiness' factor related to the consequences of feeling tired in the day.

### 3.2 Well-Being Outcomes

First, overall well-being was shown to be highly correlated with the established predictors, namely social support ( $r = 0.41$ ), negative coping ( $r = -0.54$ ), positive personality ( $r = 0.73$ ) and total stressors ( $r = -0.52$ ).

Further, well-being was not significantly associated with overall academic attainment in students, ( $r(343) = 0.05$ , ns.), nor was it correlated with exam or coursework marks ( $r(343) = 0.08$ , ns., and  $r(343) = -0.02$ , ns., respectively).

Univariate correlational analyses were used to examine the relationship between sleep factors and overall well-being. Results revealed that 3 of the 4 sleep factors were significantly correlated with overall well-being outcomes (tiredness and concentration:  $r = -.056$ ; Sleep quality:  $r = 0.43$ ; Daytime sleepiness:  $r = 0.29$ ). No significant relationship was found between Factor 2 'sleep duration' and well-being ( $r(343) = 0.07$ , ns).

Multiple regression analysis was used to test if the sleep factors predicted well-being outcomes whilst also taking the established predictors of well-being into account. The results of the regression indicated that when controlling for total stressors, negative coping, social support and positive personality, only Factor 1, 'tiredness and concentration', remained significant (see Table 3).

**Table 3** Summary of multiple regression analysis for students' well-being.

Predictor	B	SE (B)	$\beta$
Tiredness and concentration	-1.66	0.82	-0.14*
Sleep quality	1.21	0.76	0.10
Daytime sleepiness	0.38	0.71	0.03
Stressors	-0.32	0.08	-0.24*
Negative coping	-0.46	0.18	-0.18*
Social support	0.15	0.11	0.08
Positive personality	0.96	0.19	0.39*

Note.  $R^2 = .69$ , \* $p < .05$

Next, it was appropriate to explore whether specific questions of Factor 1 ‘tiredness and concentration’ significantly predicted well-being and which aspects of this factor were the major predictors. Correlational analysis revealed that all four questions significantly correlated with well-being (Do you often sacrifice sleep for studying?  $r = -0.28$ ; Do you often feel tired during the day?  $r = -0.50$ ; Do you often feel tired during lectures?  $r = -0.45$ ; Do you find it hard to concentrate during lectures?  $r = -0.50$ ). However, when taking into account established predictors of well-being (social support, negative coping, positive personality and total stressors), only ‘feeling tired during the day’ and ‘finding it hard to concentrate’ significantly predicted well-being (see Table 4).

**Table 4** Summary of multiple regression analysis for students’ well-being for Factor 1.

Predictor	B	SE (B)	$\beta$
Do you often feel tired during the day?	-0.99	0.24	-0.18*
Do you often sacrifice sleep for studying?	-0.07	0.15	-0.02
Do you often feel tired during lectures?	0.26	0.29	0.05
Do you find it hard to concentrate during lectures?	-0.51	0.25	-0.09*
Stressors	-0.25	0.05	-0.19*
Negative coping	-0.53	0.10	-0.20*
Social support	0.25	0.07	0.13*
Positive personality	1.03	0.09	0.44*

Note.  $R^2 = 0.70$ ,  $*p < .05$

Looking at specific aspects of well-being, it was found that subjective depression and anxiety were significantly correlated with aspects of sleep. Specifically, subjective depression was correlated with tiredness and concentration ( $r = 0.41$ ), sleep quality ( $r = -0.39$ ) and daytime sleepiness ( $r = -0.30$ ), and subjective anxiety was correlated with tiredness and concentration ( $r = 0.55$ ) and sleep quality ( $r = -0.27$ ).

### 3.3 Academic Attainment

Academic attainment was shown to be correlated with each of the established predictors: conscientiousness (overall:  $r = 0.24$ ; exam:  $r = 0.17$ ; coursework:  $r = 0.37$ ) total stressors (overall:  $r = 0.17$ ), how efficiently one does their work (overall:  $r = -0.14$ ), and how stressful students find their course (coursework:  $r = 0.12$ ). Conscientiousness was the strongest predictor of academic attainment. Univariate correlational analyses were used to examine the relationship between sleep and academic attainment. Results revealed that only Factor 1 ‘tiredness and concentration’ was significantly correlated with academic attainment,  $r(343) = 0.23$ ,  $p < .05$ . Multiple regression analysis was used to test if ‘tiredness and concentration’ predicted academic attainment whilst adjusting for the established predictors of attainment, namely conscientiousness, stressors, how effectively one does university work, and how stressful students find their course. This analysis showed that ‘tiredness and concentration’ did significantly predict overall academic attainment

when controlling for these factors ( $\beta = .29$ ,  $t(343) = 2.90$ ,  $p < .05$ ). Next it was appropriate to explore whether specific questions in Factor 1 'tiredness and concentration' were significantly correlated with academic attainment to discover whether one particular result was leading the association. No significant correlations were found.

All of the regressions were using only the female participants. This had no effects on the results reported above.

#### **4. Discussion**

Due to reports of the consequences of lack of sleep in adolescents and children [i.e. 20, 21, 36, 38, 39], the current study aimed to establish whether variations in sleep significantly affected the well-being and academic attainment of university students. It was hypothesised that those students with insufficient sleep would experience negative effects on their well-being and achieve poorer grades in university, and this would remain significant when controlling for the established predictors of both well-being and academic attainment.

Analyses indicated that the 11 sleep questions could be divided into four independent factors, namely tiredness and concentration, sleep duration, sleep quality and daytime sleepiness. Initial positive relationships were observed between well-being and three factors of the sleep questionnaire, namely tiredness and concentration, sleep quality and daytime sleepiness. After adjusting for social support, positive personality, negative coping and total stressors - which were all significantly correlated with overall well-being - the effect of sleep quality and daytime sleepiness disappeared, with only tiredness and concentration remaining significantly associated. Specifically, feeling tired during the day and finding it hard to concentrate during lectures were significantly linked with negative well-being outcomes. This provides some support for the hypothesis regarding well-being, which implied that poor sleep would be correlated with decreased well-being in students. This is also consistent with previous research showing that poor sleepers experience numerous negative impacts on their well-being and functioning [7].

Previous research has suggested that sleep problems are related to anxiety disorders. Indeed, Gregory and colleagues [21] found that children with sleep disorders early in life were significantly more likely to present with an anxiety disorder 20 years later. In the current analysis, it was found that self-reported anxiety was significantly associated with tiredness and concentration and diminished sleep quality in this student sample, which supports the hypothesis that those who have insufficient sleep would experience negative effects to their well-being. Therefore, poor sleep can negatively affect anxiety outcomes in university students as well as in children.

Furthermore, this research aimed to discover whether poor sleep was associated with a specific aspect of negative well-being namely depression. Results showed that depression was significantly associated with the tiredness and concentration factor, and negatively correlated with sleep quality and reduced daytime sleepiness, which supports the research hypothesis and previous reports of this association. For example, Pilcher and colleagues [23] reported that individuals with poor sleep quality who experience daytime sleepiness were more likely to display depressive symptoms. Further, students with depressive symptoms were those more likely to suffer alterations to their sleep, suggestive of a bi-directional relationship between sleep and affective disorders [42]. Given the rumination of thoughts that symbolise depression, this is to be expected, and can lead to intensified levels of physiological arousal which is likely to affect sleep [43].

Therefore, a similar bi-directional relationship may be evident in university students, whereby disturbed sleep causes negative well-being and depression outcomes, and with this depression causing further problems with sleep.

In relation to academic performance, findings suggested that only tiredness and concentration, and no other aspect of sleep, was significantly correlated with attainment. It was also evident that this factor was significantly linked with poor academic attainment when adjusting for established predictors of attainment, including conscientiousness, total stressors, how efficiently one does their work, and how stressful students find university. These results also provide support for previous research, which suggest that the negative consequences of insufficient sleep, such as tiredness during the day and concentration, have a significant impact on academic performance [44]. It is possible that this association is based on the idea that insufficient sleep reduces brain activity over night, which is needed for daily cognitive functioning in the prefrontal cortex [45]. The impairment of the prefrontal cortex function, which is known to be sensitive to sleep [46], may result in the decline in academic performance shown here.

However, it has recently been suggested that the use of a 'power nap' for those who do not meet their sleep needs can improve daytime functioning significantly [47]. According to researchers, a nap at noon can rejuvenate, revitalize and increase health for those who do not meet their sleep needs during the night [47]. However, other activities, such as part-time work, may make it difficult to take a nap.

The present findings support research showing that it is mental fatigue that reduces well-being and leads to poorer academic attainment [48]. Regarding sleep duration, the findings presented here are in line with previous research indicating that there is no relationship between sleep time and academic performance [36, 37]. However, contrary to current findings, it has been shown that students who reported lower-end grades had 25 minutes less sleep per night than those who reported A or B grades [38]. There is also experimental support for the importance of sufficient sleep time for academic functioning. For example, restricting sleep from 10 to 6.5 or 8 hours per night for three weeks results in more academic and attention problems [49]. Therefore, due to contrary laboratory evidence, it is likely that the lack of association between sleep duration and attainment here could be due to methodological differences.

Proposals have recently been put forward to move school and lecture start times later in the morning, to improve functioning in adolescents and students. Indeed, it has been found that a start time delay of 30 minutes is associated with a decrease in the ratings of daytime sleepiness, and students also rated themselves as less depressed and more motivated in class [50]. Therefore, there are policies for local education authorities to consider regarding start times for students to decrease the negative effects of insufficient sleep. However, the existing research on sleep duration is mixed, and so clarification of these findings is required before any changes can be put in place.

Previous research has also suggested a link between negative well-being and diminished academic attainment, although no relationship was found in this research. For example, Surtees and colleagues [18] showed that students with anxiety or depressive conditions in the first year of university reduced the likelihood of academic prowess, and it has been suggested that students' health complaints reduce the capacity to perform to standard at university [33].

#### **4.1 Limitations**

There are some specific limitations associated with the current research. First, the study design was correlational, meaning that no causal inferences can be made between sleep, well-being and academic attainment. For example, it is possible that rather than aspects of sleep having an effect on well-being, it could be that the poor well-being of students is having an effect and preventing sufficient regular sleep. Therefore, no causal conclusions can be drawn from this type of research. Correlations between reports of sleep and outcomes such as depression or anxiety may also be biased due to the participants reporting on both factors within the same survey, and that other unmeasured attributes of the individual could account for the associations. This area of research requires more intervention studies in order to clarify the cause-and-effect relationships between sleep, well-being and academic attainment. One possible way to objectively measure sleep is through the use of actigraphy (activity-based monitoring), which detects movements while sleeping [51]. This has been used in previous sleep research, and could be a potential tool with which subsequent academic performance and well-being can be measured against.

Secondly, although a sufficient sample size was used in this research, the sample was limited in numerous ways. The sample was restricted to Psychology undergraduate students, with a mean age of 19. Results of this sample may not generalisable beyond UK students who are in their late teens and early twenties, and further research is required using male and female students from other disciplines. There are also obvious limitations and risks with the use of psychology students, as they are potentially more aware than other populations of what is being tested, and may alter their answers accordingly. It is essential to test other age groups in future studies of the effects of sleep on well-being and attainment. Recently, the Great British Sleep Survey [52] found that 49% more people over 60 suffer from long-term sleep problems than those in their twenties, suggesting that as we get older, sleep quality decreases. Therefore, a randomised, population-based study with a large sample size is required to extend the findings of this research.

Thirdly, the majority of the current sample were female, with over 300 women completing the survey. Previous research has documented that female students generally have poorer sleep patterns than males and suffer more consequences as a result [53]. Although the average college student displays some form of sleep disruption, women tend to report more disturbances than men [7], and these women are at a greater risk of physical, social and emotional problems, as well as poor academic performance [34]. As such, it would be beneficial to consider the differences between genders when attempting to understand the link between sleep, well-being and academic attainment.

Finally, this study only measured student well-being and performance at a single time-point of the academic year. This can be somewhat inadequate in capturing the difficulty of university life as it changes throughout the years. It can also lead to the assumption that there is no variation in psychological well-being in particular across the academic year. Indeed, without a baseline measure of well-being prior to university, only assumptions can be made by research about the impact of university on students' well-being, as it fails to measure this major change in life. This research also measured the effects of sleep in the first and second year of university. However, these years have the potential to be somewhat different in their degree of difficulty and the degree with which students are able to cope with academic pressures and being away from their

home environment. Therefore, comparisons between these two years should be made to capture the different effects on well-being and attainment.

## **4.2 Implications**

According to Wolfson & Carskadon [38] adolescents and students would experience fewer variations in mood and fewer behavioural difficulties if they had the opportunity to achieve more sleep per night. Education, put in place at the start of the first year at university to provide insight into the negative impacts of insufficient sleep, could be beneficial. When students enter university, they may be unaware of how to balance their university work and social life effectively, so their sleep is likely to suffer. This could be due to students having control over whether they stay up late, whether they go to early morning lectures or whether they have a lie in because they are away from their home environment. Counselling cannot alter the unavoidable, but it does make students more self-aware, and able to cope better with adverse consequences [54].

This research and previous studies have shown that poor sleep does have an impact on attainment at university [38, 39]. Current educational messages about improving sleep tend to focus on the number of hours slept, rather than sleep quality and its impacts on academic attainment. However, it has been shown that sleep quality is important in student functioning [34], and therefore the negative effects should be conveyed to students. Although some aspects of sleep were not significantly associated with overall well-being or academic attainment in the current research, they should still be addressed. The aspects of sleep that were found to be associated with well-being and attainment were those endorsed by a significant percentage of the sample. Thus, to influence the entire sample, some aspects of sleep may not occur often enough, but could greatly impact individual participants [55]. As such, when it comes to intervention, all aspects of sleep should be considered when discussing negative effects on well-being and academic attainment.

It is concerning that educators currently fail to recognise those students who potentially have disrupted sleep patterns, and that physicians fail to ask about sleep. Indeed, Owens [56] found that 44% of doctors did not regularly screen for sleep disorders in adolescents, the population who are at the highest risk. To see improvements, public health practitioners ought to support and provide health-promoting information to university students, at a national level, to tackle the growing health concerns [57]. Despite the impact of sleep difficulties on the development of young people, changing sleep patterns through education programmes has been given little consideration [58]. It would transpire that if education programmes can change knowledge and subsequent behaviour regarding physical activity and diet, then similar results should occur within sleep education programmes. The few current sleep intervention studies have found mixed results with some improving daily sleep [59, 60], while others have found no change [61]. Developing effective sleep education programmes to examine the influence on sleep practices in students has the potential to be a tool through which researchers can develop successful interventions to treat those who are at risk of sleep difficulties.

## **5. Conclusions**

Sleep problems and difficulties have a profound influence on the lives of students. The current research confirmed that poor sleep is a challenge for university students, and that sleep may be

linked to concerns regarding well-being and academic attainment. This survey adds to the growing literature suggesting that students who suffer from sleep problems have an increased likelihood of experiencing anxiety and depression outcomes, and unsatisfactory performance at university. Further research that manipulates sleep is required in order to fully explore the links between sleep, well-being and academic attainment in students. As sleep relates to many aspects of student health and performance, interventions targeting sleep improvements have the potential to improve both the health and academic success of university students.

### **Author Contributions**

Both authors contributed to the design, data collection and analysis of the data. They also both contributed to the writing of the final version of the paper.

### **Competing Interests**

The authors have declared that no competing interests exist.

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